ARS Grape and Wine Industry Workshop
Pest and Disease Management Presentation
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Introduction:

The study of plant-microbe/pest interactions is an interdisciplinary science that relies on the collaboration of pathologists, entomologists, weed scientists, geneticists, microbiologists, plant physiologist, and biochemists just to name a few. Consequently, given the nature of the science, the number of ARS scientists working on pest and diseases of grape is rather large with approximately 30 scientists devoting any where from 10% to 100% of their research efforts in this area. These scientists can be found in 13 different ARS research locations which are spread across 11 states representing all 8 of the ARS administrative areas in the United States.

For the purpose of this discussion, organisms which adversely affect grapevine health and productivity were divided into three categories. They include; **1.) Microorganisms**, 2**.) Insects**, and **3.) Weeds** in which ARS has 14, 16, and 2 scientists working respectively. In this presentation I will not address the work ARS is doing in Weed research since that information will be presented in the section entitled, "Physiology, Cultural Practices/Sustainability".

Here we will present the work being conducted in the first two categories by subdividing each category into more manageable pieces. The first category, Microorganisms, was divided into the following four subsections; Bacteria, Fungi, Viruses and Nematodes in which ARS has 5, 4, 2 and 3 scientists working respectively. The second category entitled, Insects, was divided into two sections; Glassy-winged Sharpshooters (GWSS), and non-GWSS.

1.) MICROORGANISMS

Bacteria:

As one might guess, the bulk of the grape related bacterial research involves an examination of the genetics, ecology, and biology of *Xylella fastidiosa*, the causative agent of Pierce's Disease (PD).

To begin to understand the exterior of the bacterial cell, Dr. N. Price has examined *Xylella* LPS structure and has developed antibodies to the o-antigen region which may be useful in the development of enhanced, simple, cheap, and robust detection bioassays that could be performed on the tailgate of a pickup parked in the vineyard.

Dr. H. Lin from Parlier, CA is characterizing the mode of action of PD resistance observed in several *Vitis* species. This work involves an examination of such phenotypes as the antimicrobial activity of sap from resistant *Vitis* spp and its ability to inhibit *X.fastidiosa* biofilm formation which is thought to be an important virulence determinant. In addition,

Drs Chen, Groves and Lin in Parlier, CA also are examining the genetic diversity of *X.fastidiosa* collected from both grape and almond plants. Using small nucleotide polymorphism analysis (i.e. SNP analysis) these scientists are beginning to understand the genetic structure of *X.fastidiosa* populations as a function of geography, host preference, and insect acquisition-transmission. These types of data are very important in the development of effective PD control measures.

Though not discussed in the Pest and Disease Management section, there are a number of other ARS scientist conducting work related to *X.fastidiosa*.-PD, e.g. Dr. K. Baumgartner is examining the importance that certain riparian hosts play as *X.fastidiosa* reservoirs and how that may impact PD incidence.

"Other" Bacteria:

Finally, Dr.'s Steenwerth and Kluepfel in Davis, CA are investigating the role that the rhizosphere microbial communities play in grapevine health and how these microbial communities are impacted by vineyard floor management strategies. (Dr. Steenwerth's research program is discussed more fully in the "Physiology, Cultural Practices/Sustainability" section.) In addition, Dr. G. Browne in Davis, CA, has examined what role soil-borne microbial communities play in grapevine replant problems. The outcome of this and other related replant work in Dr. Browne's laboratory may yield insights into how specific microbial community "fingerprints" may be used as indicators of soil health.

Fungi:

Currently ARS has four scientists conducting fungal research in viticultural systems. Dr. W. Mahaffee is working on the development and refinement of the Gubler-Thomas powdery mildew (PM) forecast model by examining the effects of temperature and leaf wetness on PM epidemiology in wet climates that are more typical in the grape growing regions of Oregon and Washington. In addition Dr. Mahaffee is developing methods to quantify PM airborne inoculum in addition to developing molecular DNA markers associated with resistance to DMI fungicides.

In collaboration with grape breeders, Dr. J. Smilanick (Parlier, CA) is working on the identification and characterization of powdery mildew resistant grape cultivars.

ARS also has research programs looking into ways in which Gray Mold can be controlled. For example, Dr. J. Smilanick is exploring the use of alternative chemical, physical and biological control agents for use in post-harvest Gray Mold control. In addition Dr. Smilanick is working towards the identification and characterization of Gray Mold resistant grape cultivars. In a complimentary research program Dr. W. Mahafee is working on the identification and characterization of biological control agents to control Botrytis bunch rot while designing effective delivery systems for their use in the field. All of this work is support by Dr. Mahafee's investigations into the mechanisms of plant tissue colonization/infection using marked strains of *B. cinerea* which allows Dr. Mahafee to

carefully document this interaction from fungal deposition to infection of the grape host tissue.

Armillaria Root Disease is caused by a soil-borne fungus for which there are limited control options. Dr. K. Baumgartner is exploring the use of both cultural and biological control mechanisms to control this recalcitrant fungus. In this work Dr. Baumgartner has found that the use of root collar excavations of symptomatic Armillaria infected vines resulted in increased yields and vine longevity as compared to non-treated Armillaria infected vines. This work is especially significant given the lack of effective post-plant fungicides/fumigants to control Armillaria.

In addition, Dr. G. Browne has been involved in the study of Phytophthora Root/Crown rot of grape on St. George root stock. In these studies he identified the causative agent and designed control strategies.

The last fungal related research program that I want to mention is that of Dr. B. Smith (Poplarville, MS) who has reported some interesting observations that show when Bitter Rot/Ripe Rot are controlled on Muscadine grapes, a significant decrease in the potent antioxidant, resveritrol, was measured in the grapes. Given the recent increased attention being given to the antioxidant content of grapes this research may have significant implications. In addition, Dr. Smith also is involved in the evaluation of germplasm for resistance to Bitter Rot / Ripe Rot which fits well with her work on fungicide timing and applications rates to control these diseases.

Viruses:

ARS currently supports two scientists working in the field grape virology. Dr. J. Uyemoto in Davis, CA is identifying and characterizing newly detected graft transmissible agents (GTA). This work includes the cloning and sequencing of these GTAs which facilitates the development of PCR based detection systems for these and other grapevine viruses. These protocols are being used to ensure clean stock in the grape germplasm collections. The second scientist working in this area is Dr. B. Martin who has been instrumental in determining the distribution of a variety of grape viruses in the Pacific Northwest. Dr. Martin also is characterizing the ability of vine mealy bug to transmit grapevine leaf roll viruses.

Nematodes:

Dr. J. Pinkerton has been performing large scale surveys to identify the economically important plant parasitic nematodes on grape. Dr. Pinkerton also is involved in breeding grape root stocks for resistance to root knot nematode. Interestingly, he also has found evidence to suggest that ring nematode may be more of a significant pest on grape than previously thought.

In Parlier, CA, Dr. S. Schneider is examining the use of methyl bromide alternatives for nurseries who must participate in nematode-free certification programs. In collaboration

with Dr.'s Trout and Browne, Dr. S. Schneider also is examining alternatives to methyl bromide for the prevention of replant disease. In this team Dr. Trout leads the effort to develop new application technologies to deliver soil fumigants.

2.) INSECTS

ARS supports a significant effort in the study of insects as it relates to viticultural systems. Given the breadth of work in this area it will not be possible to describe each of these programs here. At present there are approximately 15 scientists involved in some aspect of Glassy-Winged Sharpshooter biology, one scientist studying *Phylloxera* and one program examining the Blue-Green Sharpshooter.

Glassy-winged Sharpshooter

Approximately six scientists are studying GWSS biology/ecology, six are exploring or developing the use of GSWW parasitoids and three scientists are working on the discovery and characterization of microbial and viral pathogens of GWSS. This work ranges from the generation of cDNA libraries to examine GWSS gene expression as a function of life cycle, insect tissue, stress, temperature or infection with viral pathogens (Dr. W. Hunter), to an examination of host finding behavior, movement and over wintering biology (Dr. R. Groves).

It is of interest to note that the research group at the Beneficial Insects Research Lab in Weslaco, TX is responsible for identifying the origin of the GWSS that invaded California. In addition, members of this team (see interactive map for list of scientists) are surveying the native range of the GWSS in a search for new and more effective egg parasitoids (Dr. Goolsby). In collaboration with Dr. James Hagler at the Phoenix lab, Dr Jesse de Leon (Weslaco, TX) also has developed molecular diagnostic markers to aid in the identification of key GWSS predators.

In addition to developing methods to control, i.e. kill, the GWSS, several ARS scientists are working to improve methods of rearing the GWSS in the lab. This includes working on both the environmental parameters and diet composition that will make the sharpshooter "happy" in captivity (Dr. Tom Coudron, Columbia, MO). Research into diet development and mass rearing of the GWSS parasitoids is also occurring in several ARS laboratories (Dr. R. Leopold, Fargo, ND and Dr. T. Coudron).

Given the large number of ARS scientists working on GWSS, not all of them were mentioned in this narrative. To find additional information on a scientist not mentioned above please see either the Pest and Disease Management Presentation or the interactive USA map on this CD showing the location and name of each of the ARS scientists working on some aspect of Viticulture.

Non GWSS insect research projects:

Currently there are two ARS scientists conducting grape-related insect work on an insect other than GWSS. Dr. J. Fisher in Corvallis, OR is examining the effect of temperature, soil type and water potential on the ecology of *Phylloxera* in Oregon and Washington soils. In addition Dr. Fisher is investigating the potential for movement of *Phylloxera* from Oregon to the state of Washington.

The second non-GWSS insect project is being conducted by Dr. K. Baumgartner who is examining the involvement of riparian hosts in Blue Green Sharpshooter (BGSS) mediated *Xylella fastidiosa* transmission and PD incidence. This work includes an examination of such parameters as BGSS host feeding preferences and the influence of host species on *X. fastidiosa* acquisition by BGSS.